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1986–87 GRADUATE STUDENT SURVEY

There is much debate and little agreement concerning the quality of an American education; however, the education available in the United States for potential physicists has a reputation that attracts graduate students from all over the world. The 264 graduate physics programs in the United States currently enroll over twelve thousand students, a majority of whom spend approximately six years in such a program because it requires them to choose a specialty and complete a dissertation before acquiring a doctorate in physics.

The Graduate Student Survey monitors the progress of all graduate physics students and analyzes changes in their characteristics. Since 1960 this population has increased steadily but not uniformly with respect to its major characteristics. In gathering these data we request each graduate student to contribute information on his or her educational background, the current student status, choice of subfield and employment prospects where applicable. The highlights of this report are:

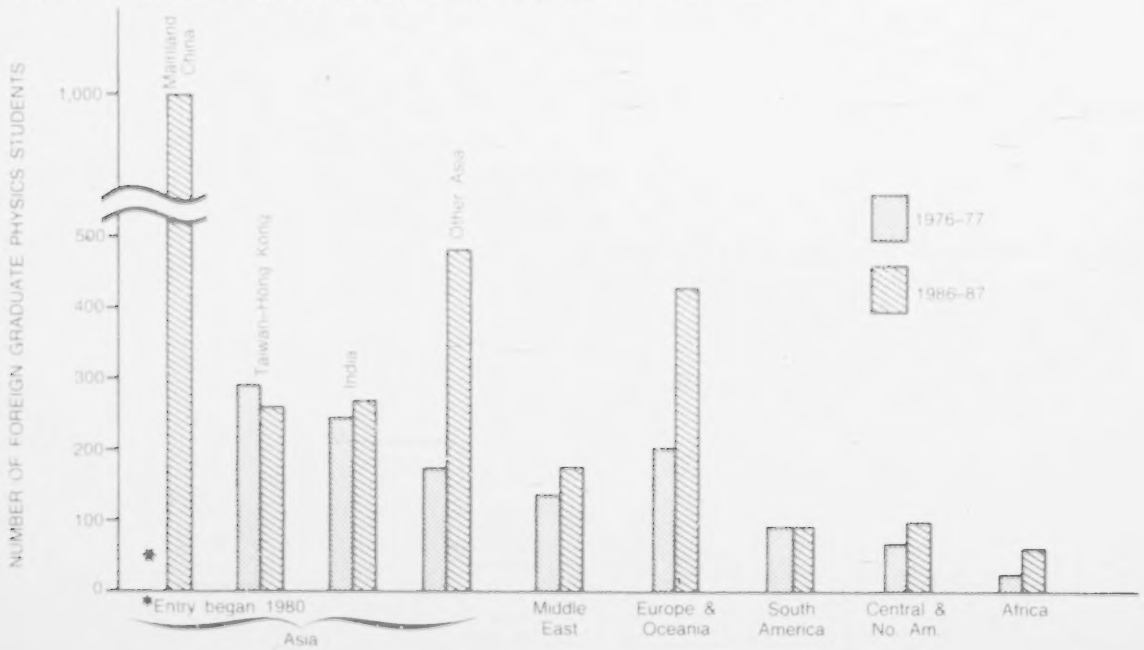
►There has been a large increase of physics students from Mainland China.

►There is a lower attrition of graduate physics students at private than at public institutions.

►74% of the foreign doctorate recipients remain in the U.S. for postdoctoral training or initial employment.

A key characteristic that continues to attract a great deal of attention is the citizenship of graduate physics students. In the most recent ten-year period the proportion of foreign graduate physics students increased from 25% to 40%. An increase of that magnitude aroused interest in those students' countries of origin. Hence we present **Figure 1** which compares the responses from 1200 foreign physics graduate students in 1976-77 with those of 2900 students in 1986-87. The bar graph indicates in some detail the countries and regions these students came from. Since Mainland China only began to send graduate physics students to the United States in 1980, the tallest bar in **Figure 1** represents an increase from zero. Students from Hong Kong and Taiwan recorded the largest proportional decline; they comprised 24% of the foreign students in 1976-77 and only 9% of the corresponding total of 2900 in

Figure 1. Origins of foreign graduate students, 1976–77 and 1986–87.



Member Societies The American Physical Society • Optical Society of America • Acoustical Society of America • The Society of Rheology • American Association of Physics Teachers American Crystallographic Association • American Astronomical Society • American Association of Physicists in Medicine • American Vacuum Society • American Geophysical Union

Table I. Characteristics of the graduate physics student population, 1986–87.

Characteristics		All graduate students	First-year graduate students	Degree recipients: Terminal masters	Degree recipients: Doctorate recipients
	Total population	12,616	3,162	623	1,105
	Number of respondents	7,105	1,364	295	710
Sex	Female	13%	15%	16%	9%
	Male	87	85	84	91
Citizenship	U.S.	61%	57%	82%	62%
	Foreign	39	43	18	38
Physics in high school	Yes	93%	91%	90%	94%
	No	7	9	10	6
Major of bachelor's degree	Physics	84%	84%	80%	91%
	Mathematics	3	3	3	3
	Engineering	6	9	7	3
	Other phys. science	3	2	4	2
	Other	4	2	6	1
Type of bachelor's institution	PhD-granting	41%	35%	34%	45%
	MS-granting	6	7	17	3
	BS/BA-granting	17	19	32	15
	Foreign	36	39	17	37
Type of graduate institution*	PhD-granting	90%	84%	79%	100%
	MS-granting	10	16	21	–
	Public	69%	73%	79%	62%
	Private	31	27	21	38
Source of support	Teaching assistantship	34%	55%	35%	10%
	Research assistantship	45	15	14	70
	Fellowship	8	9	3	10
	Employment (full-time)	4	9	30	3
	Family, savings, loan	3	6	6	3
	Other	6	6	12	4

* *These data were derived from the survey of Enrollments and Degrees.*

1986-87. Only the largest Asian countries were singled out in **Figure I**, hence some additional details worth noting are: The number of Korean students quadrupled from 60 to 240 as their proportion increased from 5% to 8%, Japanese students remained at approximately 2%, students from Australia and New Zealand (comprising 1%) were included with Europe, and Canada is the foreign country listed as "North America."

Table I presents eight characteristics of the total graduate physics student population as well as those of three subgroups, namely the first-year students, the terminal masters and the doctorate recipients. Our annual survey of Enrollments and Degrees establishes the total population in each of these groups, forming a base for interpreting the responses to the Graduate Student Survey. The first two rows of **Table I** present these numbers.

A new characteristic, not included in earlier reports of this survey, divides the graduate enrollment into public and private institutions and reflects on their comparative attrition rates. Only 27% of the first-year graduate students enroll in private institutions, but these institutions confer 38% of the total number of physics doctorates.

The influx from other disciplines to physics at the graduate level is generally small, as illustrated by the fourth characteristic of **Table I**. Students who transfer from engineering form the largest group among the first-year graduate students. Consistent with the discussion of **Figure I** are the increases in the category "foreign" listed among the types of bachelor's institutions.

Traditionally, beginning graduate students are offered teaching assistantships until they advance enough to qualify as research assistants. Funds for teaching assistantships in physics have always been plentiful, which is indicated in **Table I** by the fact that only 3% of all graduate physics students are obliged to use family funds or loans in order to continue their study.

The total number of survey respondents who identify themselves as members of a specific minority group is 2,500 or 35% of all respondents. **Table II** lists the minority groups and divides the larger ones on the basis of citizenship. By treating the Asian Indians and Arabs as predominantly foreign, we find that the U.S. minority groups comprise less than 4% of the respondents to this survey. Other characteristics selected for inclusion in **Table II** are intended to identify similarities and differences between the members of minority groups and the total graduate physics population. The fifth characteristic, full-time equivalent years of graduate study, serves as an example of a difference by showing a lower rate of attrition among the foreign minority groups. The distribution of all graduate students presented in **Table III** can be used for

Table II. Characteristics of minority group physics students, 1986–87

Characteristics		Total number	Black U.S.	Black Foreign	Native American Indian	Hispanic Puerto Rican	Hispanic Mexican American	Hispanic Other U.S.	Hispanic Other Foreign	Asian Indian	Oriental U.S.	Oriental Foreign	Arab
		52	32	12	19	16	31	91	387	129	1 577	174
Sex	Female	11	1	2	3	1	–	10	96	20	248	16
	Male	41	31	10	16	15	31	81	291	109	1 329	158
Candidacy for:	TMS	12	10	1	2	–	3	9	28	6	70	24
	MS and PhD	28	18	8	15	12	16	52	263	81	902	117
	PhD only	12	4	3	2	4	12	30	96	42	605	33
Student status	Full-time	42	29	11	12	16	29	88	374	111	1 537	158
	Part-time	10	3	1	7	–	2	3	13	18	40	16
Physics in high school	Yes	37	30	8	15	16	26	90	380	120	1 541	171
	No	15	2	4	4	–	5	1	7	9	36	3
Full-time equivalent years of graduate study	1	16	8	3	4	1	6	17	38	25	264	18
	2	10	6	4	1	6	6	18	93	28	345	31
	3	5	5	1	3	2	10	20	61	26	260	23
	4	4	5	2	4	1	2	6	52	18	260	25
	5	3	2	1	2	4	4	14	63	17	259	27
	6	7	3	–	3	1	3	4	44	5	119	23
	7	7	3	1	1	1	–	12	36	10	70	27
Major subfields	Condensed matter	16	16	4	6	6	5	32	155	41	698	50
	Elect. at. mol.	1	1	1		1	4	8	23	13	128	15
	Elem. particles	1	–	1	2	2	4	12	52	15	127	15
	Math. physics	6	2		3	3	5	18	29	8	81	18
	Nuclear	2	4	2	–	–	1	4	36	14	92	24
	Optics/lasers	8	–	–	2	2	4	4	22	8	120	13
Graduate degree recipients	TMS	10	3	–	2	–	3	4	39	40	67	14
	Doctorates	6	3	–	–	2	1	14	58	20	160	30

comparison. The proportion of women among the different minority groups varies widely, but remains high for U.S. blacks, for both Oriental groups and for Asian Indians, but is comparatively low for Arabs.

The data in **Table III** were scaled up to give an estimate of the total number of graduate physics students in each of the major subfields and at nine levels of graduate study. One reason for presenting this type of analysis is to make it possible to estimate the number of graduates in a given subfield who will seek employment within a year or two. Approximately two years of graduate study are required for a terminal master's degree and an average of five or six years for a doctorate. By relating the level of graduate study to the subfields in **Table III** it is possible to facilitate estimates that indicate which subfields require less time to complete a dissertation. Optics appears to be an example of such a subfield; it is also an area that has shown a steady growth in the number of graduate students.

Table III. Number of graduate physics students, by subfield* and years of graduate study completed, 1986–87.

		Full-time equivalent years of graduate study								Total graduate students	
		1 yr.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	≥9 yrs.	N	%
Distribution of students	N	3 162	2 536	1 918	1 716	1 640	958	378	192	116	12 616**	
	%	25.1	20.1	15.2	13.6	13.0	7.6	3.0	1.5	0.9		100%
Astrophysics		165	150	128	101	53	68		6	4	720	5.7
Bio/medical physics		60	85	50	45	45	30		5	5	340	2.7
Condensed matter		933	820	630	595	572	370		45	35	4 100	32.5
Electron, atomic, molecular		165	200	135	140	140	75		25	10	935	7.4
Elem. particles		355	250	245	240	270	125		30	15	1 580	12.5
Mathematical physics		235	180	175	145	140	50	2	15	10	970	7.7
Nuclear physics		236	170	140	115	135	80	40	14	15	945	7.5
Optics/lasers		260	255	150	105	100	50	25	10	10	960	7.6
Plasmas/fluids/chaos		120	90	80	100	110	65	25	20	10	620	4.9
General physics		210	95	35	15	15	10	–	–	–	380	3.0
Other subfields		423	241	150	115	60	35	28	12	2	1 066	8.5

* *The distribution of students in each subfield is based on 7071 respondents to this question.*

** *The total was derived from the survey of Enrollments and Degrees.*

Table IV. Sources of support for graduate physics students, by sex and degree status, 1986–87.

Source of support	Female	Male	Candidates for: Terminal master's	Master's enroute to PhD	PhD after master's	PhD only	Total N	Total %
Teaching assistantship	39%	33%	33%	46%	25%	35%	2 404	34
Research assistantship	40	46	12	28	59	50	3 234	46
Fellowship	8	8	3	8	8	9	544	8
Foreign government	1	1	1	1	1	1	85	1
Family, savings	4	3	6	5	2	2	228	3
Full-time employment	3	5	34	6	3	1	297	4
Other*	5	4	11	6	2	2	313	4
	100%	100%	100%	100%	100%	100%		
Total N	946	6 159	722	1 487	2 722	2 174	7 105	
respondents %	13	87	10	21	38	31		100%

* *Other includes part-time employment and the military.*

Having mentioned that the level of graduate study influences the type of support offered to graduate students, we see in **Table IV** additional details linking the support to the candidacies for specific degrees. For example, master's degree candidates are likely to be offered teaching assistantships, whereas research assistantships are more prevalent among the advanced students. Since a higher proportion of women than men are terminal master's, rather than doctoral candidates, the percentage of women holding teaching assistantships is always greater than that for men. The rapid increase in foreign students prompted us to add "foreign government" to the list of sources of support in **Table IV**; however, the data collected since 1982 indicate that very few foreign students receive financial support from their native countries.

The normal pattern of graduate education in physics consists of two years of course work followed by three or four years of research in an area of concentration that leads to a doctoral dissertation. The intensive professional work, which usually starts in the third year of graduate school, is performed either on an experimental or theoretical basis. An array of doctoral candidates grouped by type of research, subfield and level of graduate study, is presented in **Table V**. The ratio of experimentalists to theoreticians remains at 2:1.

Table V. Number* of advanced graduate physics students specializing in selected experimental or theoretical subfields by years of graduate study completed, 1986–87.

Physics subfield	Type of research	Full-time equivalent years of graduate study: 3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	9 yrs.	Total N	% Exp.	% Theo.
Astrophysics	experimental	62	57	28	43	25	11	4	230	4.9	
	theoretical	58	37	20	24	12	0	2	153		6.9
Bio/medical	experimental	43	24	26	24	13	7	4	141	3.0	
Condensed matter	experimental	490	397	393	284	132	66	58	1 820	38.7	
	theoretical	125	140	138	64	19	5	5	496		22.4
Electron, atomic, molecular	experimental	100	96	107	53	34	26	17	433	9.2	
	theoretical	28	30	22	11	9	7	6	113		5.1
Elem. particles	experimental	146	161	180	92	62	40	15	696	14.8	
	theoretical	78	56	87	56	14	6	4	301		13.6
Math. physics	theoretical	171	140	129	85	30	23	18	596		26.9
Nuclear	experimental	102	76	70	74	45	15	18	400	8.5	
	theoretical	23	41	52	22	6	6	7	157		7.1
Optics/lasers	experimental	114	85	75	36	11	9	9	339	7.2	
Plasmas/ fluids/chaos	experimental	43	68	60	34	17	17	1	240	5.1	
	theoretical	30	38	39	28	12	6	6	159		7.2
Physics applications	experimental	81	61	39	29	16	7	2	235	5.0	
Other subfields	experimental	53	38	38	22	7	4	8	170	3.6	
	theoretical	45	64	75	30	18	2	5	239		10.8
Total	experimental	1 234	1 063	1 016	691	362	202	136	4 704	100.0%	
	theoretical	558	546	562	320	120	55	53	2 214		100.0%

* *The numbers in this table have been scaled up to reflect the total number of graduate students (6918) who completed three or more years of graduate study.*

Table VI. Distribution by subfield and employment offers for doctorate recipients, 1986–87.

Physics subfield		Total in subfield	New 'postdocs'	Employment-oriented graduates	Percentage of graduates seeking potentially permanent employment in the United States received: 0 offers	1 offer	2 offers
Astrophysics		4.7%	3.0%	1.7%		60%	40%
Biophysics		3.1	2.1	1.0		71	29
Condensed matter		34.5	22.9	11.6	4%	34	62
Electron, atomic, molecular		9.2	5.9	3.3		48	52
Elementary particles		15.9	10.6	5.3	9	41	50
Math. physics		7.9	4.5	3.4	12	70	18
Nuclear		8.9	6.6	2.3	17	50	33
Optics/lasers		4.4	1.8	2.6		62	38
Plasmas/fluids/chaos		6.1	3.7	2.4	7	60	33
All other subfields		5.3	1.9	3.4	5	55	40
Total	%	100.0%	63.1%	36.9%	4%	47%	49%
	N	1097*	692	405			
All experimental subfields			432	284	2%	48%	50%
All theoretical subfields			260	121	8%	62%	30%

* *This total does not include an estimated 8 graduates who were not interested in immediate employment, see Figure III. This total was derived from the survey of Enrollments and Degrees.*
Note: The "job offer" portion of this table does not include graduates with commitments to foreign employers.

Degree recipients

Table VI describes two types of initial employment available to new doctorate recipients: postdoctoral fellowships or positions with potential permanence. Foreign graduates are generally limited to the first category because the U.S. immigration laws permit only temporary employment in the U.S. for work that is directly related to the area of study and on the assumption that such employment is not available in the graduate's native country. Graduates who are U.S. citizens and are interested in initial employment with potential permanence, are likely to have investigated the employment opportunities of several subfields before they chose one. Thus **Table VI** provides answers to two questions: First it shows how the graduates in nine major subfields distribute themselves between the two types of initial work, and secondly the table presents information on job offers that were reported only by those degree recipients who have sought potentially permanent employment. Reporting on offers for 'postdocs' would not be meaningful because those temporary fellowships are in great supply.

A further analysis of the demand for new doctoral physicists is provided in the last two rows of **Table VI** which distinguish between experimentalists and theoreticians. The proportion of job offers each group received clearly indicates that the experimentalists are in greater demand because a larger proportion of them received multiple offers to choose from, and only 2% (compared with 8% of the theoreticians) reported no offers at the time of the survey.

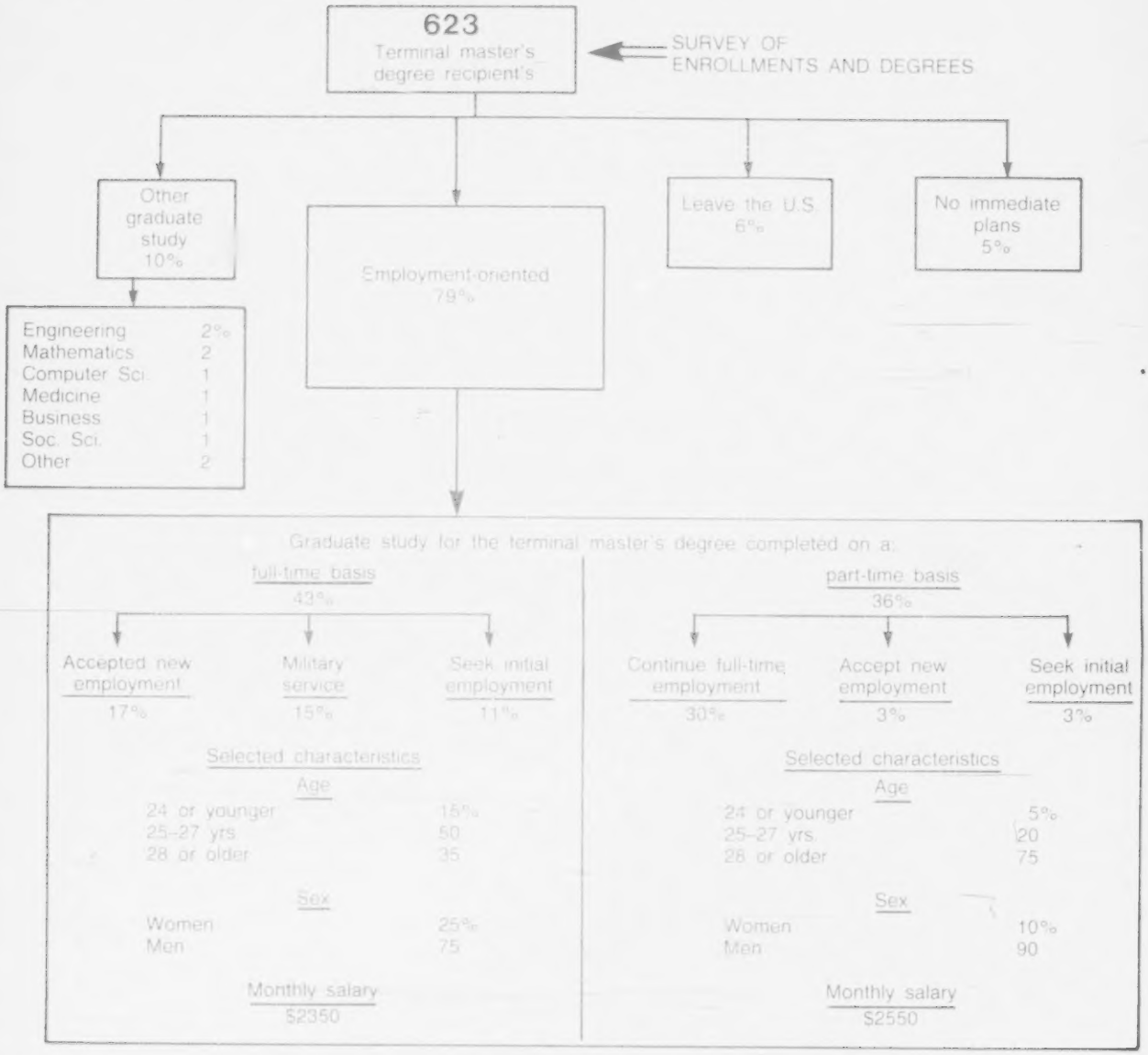
To present a broader view of the demand for physicists we need to include employment opportunities in both the U.S. and abroad, as well as the limitations encountered by foreign graduates, many of whom would like to accept initial employment in the U.S. Neither a student visa nor an exchange visa permits a foreign graduate to accept potentially permanent employment in the U.S.; however, it is possible for foreign doctorate recipients to find employers who are willing to go through the legal procedures necessary to convert those visas to permanent resident visas. **Table VII** includes 26 foreign citizens who fell into that category. The table focuses on the influence that citizenship has on the employment status of new doctoral physicists. Despite the larger number of foreign graduates, the proportion able to secure potentially permanent employment in the U.S. leveled off at 10%; almost two-thirds of the foreign graduates accepted 'postdocs' in the U.S.

Table VII. Employment of doctoral graduates by citizenship, 1986–87.

Doctoral graduates		U.S. employer 'Postdoc'	U.S. employer Accepted	U.S. employer Cont.	Foreign employer 'Postdoc'	Foreign employer Accepted	Uncommitted	Total N	Total %
U.S. citizens		227	152	21	22	1	15	438	62
Foreign citizens		171	25	1	25	33	12	267	38
Total	N	398	177	22	47	34	27	705	
	%	56	25	3	7	5	4		100%

Note: Three doctoral graduates had no immediate plans and two graduates reported "other graduate study."

Figure II. Post-degree plans of physics terminal master's degree recipients, 1986–87.



Note: Data on the characteristics of terminal masters were derived from 295 respondents.

The expectations of physics bachelors, concerning the extent to which their initial employment will utilize their training, frequently result in disappointments. Too many undergraduate physics majors are misled into thinking that upon completing their bachelor's degrees, they are physicists. As they become aware of that misunderstanding and realize that graduate training is essential to becoming physicists, hundreds of students each year return to graduate school but are unwilling to commit an additional six years to the study of physics. The alternative

Table VIII. Distribution of terminal master's by subfield and use of physics training, 1986–87.

Physics subfield	Total in subfield	Post-degree use of subject matter: extensive	little	none
Astrophysics	5%	25%	75%	
Bio/medical physics	4	100		
Condensed matter	23	72	22	6%
Electron, atomic, molecular	7	78	22	
Math. physics	5		100	
Nuclear physics	6	17	83	
Optics/lasers	16	66	34	
Physics applications	13	50	29	21
Plasmas/fluids/chaos	5	75	13	12
All other subfields	16	50	39	11
Total	100.0%	61%	35%	4%

* *Based on 295 respondents.*

for this group is to enroll in terminal master's degree programs. Studying on a full-time basis, the degree can be completed in two years. On the other hand, one-third of the terminal masters each year studied for that degree on a part-time basis while working full-time. Many master's institutions schedule all their classes after 5 p.m. to accommodate local industry whose employees are eager to further their education. **Figure II** focuses on the physics masters in the graduating class of 1987. There were 623 degree recipients and only 10% of them used that physics training as background for further studies in another discipline. The large employment-oriented group was almost evenly divided between graduates who completed their terminal master's degrees on a full-time or a part-time basis. But the characteristics and employment opportunities of these two groups differed significantly. The group that studied on a full-time basis included more women, and its members were younger and less experienced, which accounts for a lower median starting salary. A majority of the former "part-time" graduate students continued the employment that supported them through graduate school; only very few of them reported "seeking employment."

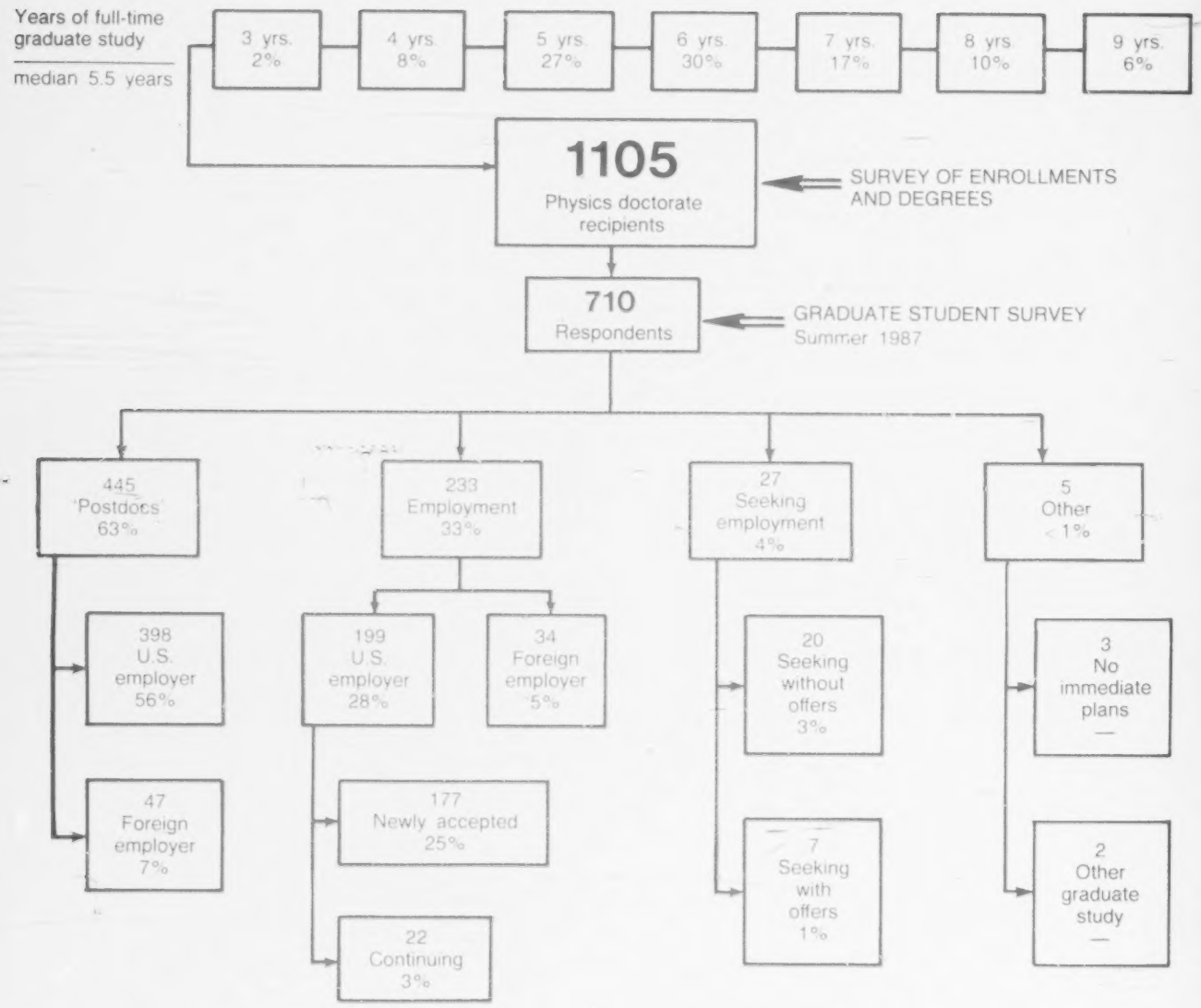
The foreign degree recipients among the terminal masters in **Figure II** comprise the 6% who reported leaving the U.S., while others are included among those who transfer to "other graduate study."

The areas of concentration chosen by master's degree candidates for their dissertations are presented in **Table VIII**, which shows the extent to which the graduates utilize their specialties in post-degree employment. Six types of employers are listed in **Table IX**, which links them to the major work activities reported by the graduates. As in past years industry remains the largest single employer where new masters perform engineering tasks as well as research and development activities.

Table IX. Employment characteristics of 1986–87 recipients of physics master's degrees.

Work activity		Type of employer: University	College	Secondary school	Industry	Military service	Government	Other	Total: N	%
Teaching		6	10	2			3		21	11
Research		10			6	4	4		24	13
Res. and dev.		2			44	14	10	2	72	38
Engineering		1			28	12	6		47	24
Comp. science					8				8	4
Nonphysics prof'l					4	16			20	10
Total	N	19	10	2	90	46	23	2	192	
	%	10	5	1	47	24	12	1		100%

Figure III. Post-degree plans of physics doctorate recipients, 1986–87.



The flow diagram of **Figure III** focuses on the 1986-87 physics doctorate recipients by highlighting and augmenting the data presented in **Tables I, VI** and **VII**. The wide range in number of years required to complete a physics Ph.D. reflects the diversity of doctoral candidates at U.S. universities. Foreign students, some of whom enter at advanced levels of study, are not the only contributors to this diversity. Undergraduate programs at U.S. colleges and universities range widely in quality; consequently some graduates require additional years of study. The major change in post-degree status involves a further shift toward 'postdocs' and away from potentially permanent positions. Details of this trend have been discussed in connection with **Table VII**. The proportion of new physicists seeking employment at the time of the survey increased from 2% to 4% in the most recent year because the number of foreign graduates included here tripled in one year.

Table X. Use of physics in potentially permanent employment for graduate degree recipients, 1986–87.

	Major employer	Extensive use of physics training with respect to: Method	Subject matter	Number responding to question
Doctorate recipients	University	86%	85%	40
	Industry	74	61	92
	FFRC	93	86	14
	Government	94	69	34
	All employers	79%	72%	180

		Use of physics training with respect to subject matter: Extensive	Little	None	Number responding to question
Terminal masters	Educational inst.	86%	14%	–	24
	Industry	54	42	4%	80
	FFRC/gov't.	57	39	4	53
	All employers	61%	35%	4%	157

When accepting potentially permanent employment, the two groups of graduate degree recipients view the use of physics training differently. Doctorate recipients are concerned about working in their subfields as well as using the research methods they developed over several years. Terminal masters, who spend less time in graduate school, are primarily concerned about the extent to which they will utilize the subject matter of their specialization. The two parts of **Table X** summarize the responses from 180 doctoral physicists and 157 terminal masters. The major types of employers are listed for both groups and it appears that for each type of employer more doctoral physicists are making extensive use of the research methods than of their subject matter.

Compared with the previous year's respondents, fewer terminal masters reported extensive use of their specialty. However, the small number of graduates employed by educational institutions formed the exception.

Table XI elaborates on the data on employment offers for new doctoral physicists, reported in **Table VI**, by listing five types of employers whose offers were accepted by the graduates. In listing the traditional work activities along with engineering, we find the proportion of graduates involved in engineering tasks has declined significantly. In 1980-81, 12% of the new doctoral physicists described their initial work activity as "engineering"; that proportion has steadily decreased so that only 5% fell into that category among the classes of 1986 and 1987.

Table XI. Employment with potential permanence for 1986–87 physics doctorate recipients.

Work activity		Type of employer: University	College	Industry	FFRC	Government	Other	Total N	Total %
Teaching		6	8	–	–	–	2	16	8
Research		8	–	20	8	5	3	44	22
Res. and teaching		27	8	–	–	1	–	36	18
Res. and dev.		2	–	63	7	7	1	80	40
Engineering		–	–	9	–	–	1	10	5
Computer science		1	–	6	–	–	–	7	4
Other		–	–	2	1	2	1	6	3
Total	N	44	16	100	16	15	8	199	
	%	22	8	50	8	8	4		100%

Table XII. Median monthly starting salaries paid by U.S. employers to new physics degree recipients, 1987.

Type of Employer	Bachelor's degree recipients		Terminal master's degree recipients		Doctorate recipients			
	Percentage accepting positions	Monthly starting salaries	Percentage accepting positions	Monthly starting salaries	Percentage accepting: 'Postdocs'	Potentially perm. pos.	Monthly starting sal. for: 'Postdocs'	Potentially perm. pos.
Secondary school	6%	$1510	1%	$1710	–	–	–	–
College	1	1480	8	1625	–	3%	–	$2000
University	3		16	1700	49%	7	$2050	2410
Industry	46	2180	51	2730	3	17	3100	3600
Gov't. inc. mil.	41	1625	22	2450	5	3	2350	2875
Fed. funded res. ctr.	2	2330	1	–	8	3	2250	3330
Other	1	1780	1	2500	1	1	*	3500
All employers	100%	$1890	100%	$2400	100%		$2080	$3400

**Insufficient data.*

Starting salaries presented in **Table XII** include only those paid by U.S. employers for newly accepted positions. Therefore the new physicists described in **Figures II** and **III** as "continuing employment" are not included in this table. Since so large a proportion of the terminal masters fall into the "continuing" category, as shown in **Figure II**, we listed two median salaries in that figure. Doctoral physicists are divided into two groups in **Table XII** because those starting potentially permanent employment are paid significantly higher salaries than those who accepted postdoctoral fellowships. For purposes of comparison, the starting salaries of physics bachelors were included in Table XII although they were not collected as part of the Graduate Student Survey. Thus four salaries are shown for the three levels of physics degree recipients.

The increasing demand and dwindling supply of new doctoral physicists available to fill potentially permanent positions caused the median salary for this group to increase by 7% in the most recent year. The starting salaries for both bachelors and masters declined by less than 2% and 5% respectively. For bachelors it is the shift from industrial employment to the military that causes the median salary to decline for the second year in a row. New terminal masters were attracted in larger proportions to institutions of higher education as well as to industry.

ASTRONOMY

There are 45 graduate astronomy departments with an enrollment of 755 students. Twelve of the departments grant both astronomy and physics degrees. Each year all graduate astronomy students are asked to contribute information to this survey, the data being summarized in two tables and one flow diagram in this report. **Table XIII** relates the

Table XIII. Graduate astronomy students* by subfield and years of graduate study, 1986-87.

		Full-time equivalent years of graduate study						Total	
		1 yr.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	N	%
Distribution of students	N	173	144	121	113	106	98	755	
	%	23%	19%	16%	15%	14%	13%		100%
Astronomy subfields									
Astronomical instruments and techniques		7%	8%	5%	2%	1%	3%	37	5%
Cosmology, extragalactic objects, quasi-stellar objects		24	19	29	31	23	30	190	25
Galactic structure, stellar motions		11	7	4	6	7	3	48	6
Interstellar matter and gaseous nebulae		8	16	12	9	26	16	109	15
Solar system, space astronomy of the solar system		8	7	5	3	8	8	50	7
Stellar atmospheres and spectra, stellar evolution, solar and stellar interiors		13	15	17	21	19	18	127	17
Supernovae, X, γ and cosmic rays, pulsars		7	3	3	4	4	3	31	4
The sun		1	2	–	4	1	3	15	2
Astrophysics		14	9	12	13	4	8	77	10
All other subfields combined		7	14	13	7	7	8	71	9
		100%	100%	100%	100%	100%	100%		

** The percentages shown in this table are based on 512 respondents to the Graduate Student Survey. Astronomy department chairpersons reported a total of 755 graduate students for the survey of Enrollments and Degrees.*

levels of graduate study to the major subfields in astronomy, which include astrophysics, a subfield also listed among the physics subfields. Cosmology attracts one-quarter of the graduate students, making it the largest subfield. The second and third largest enrollments were recorded by stellar atmospheres and interstellar matter.

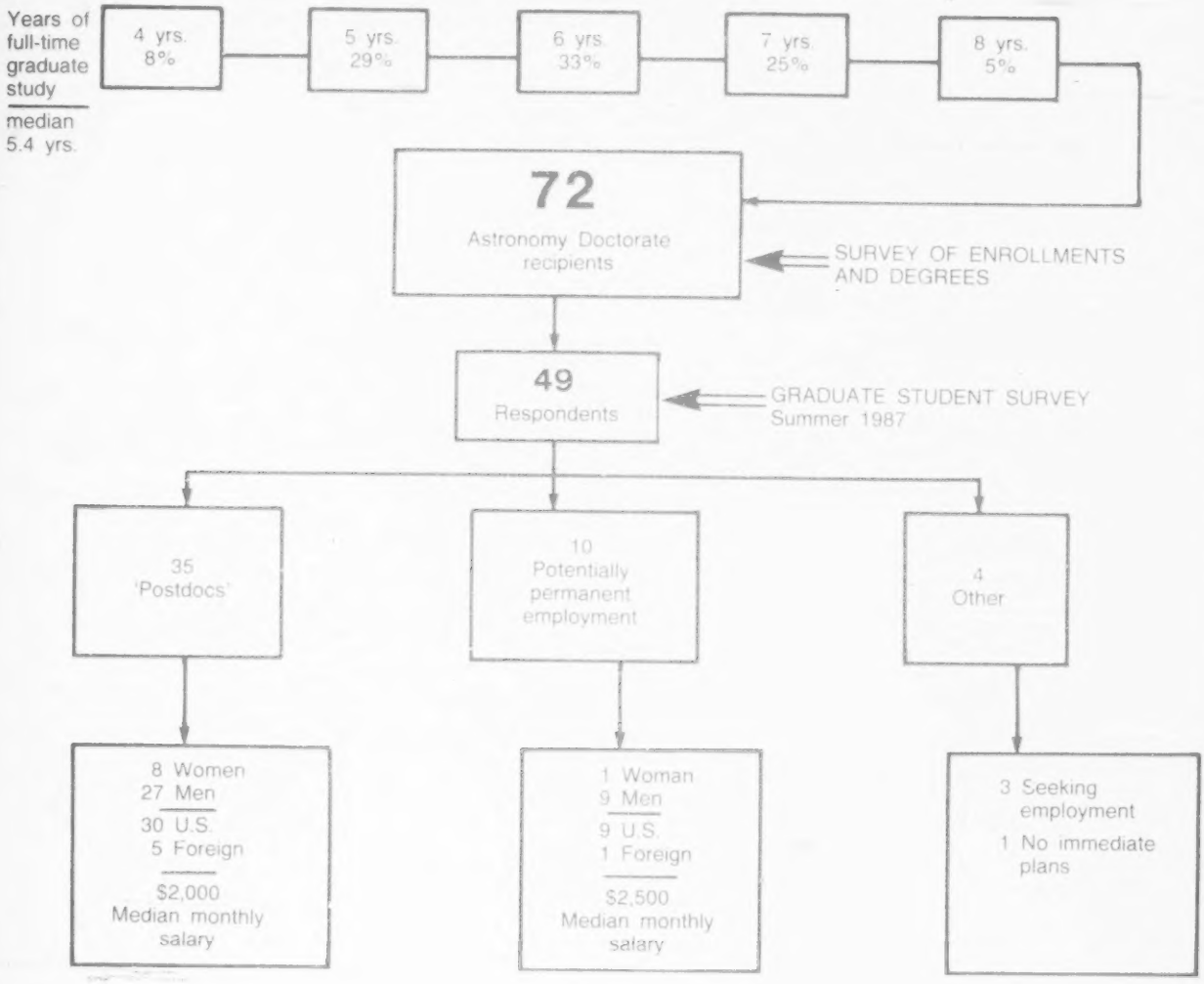
Approximately half of the graduate astronomy population were physics majors as undergraduates because so few astronomy bachelor's degree programs are available. To facilitate comparisons with the physics population, we present the characteristics in **Table XIV** in a format similar to that of **Table I**. Traditionally astronomy has always attracted a larger proportion of women and fewer foreign students; no changes along those lines are indicated. A new characteristic included this year is an analysis of the enrollment according to public and private institutions. By comparing the physics and astronomy populations we find that a smaller proportion of astronomers are enrolled in private institutions.

Table XIV. Characteristics of the graduate astronomy student population, 1986–87.

Characteristics		All graduate students	First-year graduate students	Terminal master's	Doctorate recipients
	*Total population:	755	173	23	72
	Number of respondents:	512	88	15	49
Sex	Female	20%	16%	15%	12%
	Male	80	84	85	88
Citizenship	U.S.	75%	76%	80%	88%
	Foreign	25	24	20	12
High school physics	Yes	91%	92%	87%	94%
	No	9	8	13	6
Major of bachelor's degree	Astronomy	28%	27%	14%	27%
	Physics	52	48	72	54
	Engineering	4	4	–	2
	Mathematics	3	4	–	4
	Other	13	17	14	13
Type of bachelor's institution	PhD-granting	57%	62%	54%	62%
	MS-granting	4	4	6	2
	BS/BA-granting	15	18	27	23
	Foreign	24	16	13	13
Type of graduate institution*	PhD-granting	96%	94%	87%	100%
	MS-granting	4	6	13	–
	Public	74%	70%	74%	71%
	Private	26	30	26	29
Source of support	Teaching assist.	31%	60%	67%	16%
	Research assist.	43	9	7	59
	Fellowship	14	24	–	14
	Family, savings, loans	4	5	20	–
	Foreign government	2	–	–	–
	Other	4	2	6	11
Major subfields	Cosmology	25%	24%	7%	37%
	Interstellar matter	15	8	20	8
	Solar system	7	8	7	8
	Stellar atmos. & spectra	17	11	27	16
	Astrophysics	10	15	7	8

* *These data were reported by astronomy department chairpersons as part of the survey of Enrollments and Degrees.*

Figure IV. Characteristics and post-doctorate status of 1986–87 astronomy graduates.



The data presented in **Figure IV**, which focuses on the astronomy doctoral graduates of 1987, were somewhat expanded over those included in previous versions of this report. Two median salaries are shown. The total number of astronomy doctorates conferred decreased from 86 to 72 in the most recent year, but the number of respondents was almost identical for the two years. Thus we find that the acceptance ratio of 'postdocs' to permanent positions remained the same. Three out of the 49 respondents were still seeking employment at the time of the survey.

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